Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Wednesday 11 January 2017 – Morning
Time: 1 hour 30 minutes

Paper Reference
WCH01/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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6/5/6/6/

P 4 8 3 6 7 A 0 1 2 4

Pearson

SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 20 minutes on this section. For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The Avogadro constant is equal to the number of

☒ **A** atoms in one mole of any element.

☒ **B** atoms in one mole of any monatomic element.

☒ **C** atoms in one mole of any compound.

☒ **D** ions in one mole of an ionic compound.

(Total for Question 1 = 1 mark)

2 When ethane reacts with chlorine, a mixture of products forms. Which product is the **best** evidence for a free radical mechanism?

☒ **A** HCl

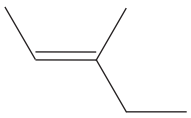
☒ **B** C_4H_{10}

☒ **C** C_2H_5Cl

☒ **D** $C_2H_4Cl_2$

(Total for Question 2 = 1 mark)

3 What is the systematic name for the compound shown below?



☒ **A** *E*-3-methylpent-2-ene

☒ **B** *E*-3-methylpent-3-ene

☒ **C** *Z*-3-methylpent-2-ene

☒ **D** *Z*-3-methylpent-3-ene

(Total for Question 3 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

4 How many straight chain isomers have the molecular formula C_3H_5Cl?

☒ **A** 3

☒ **B** 4

☒ **C** 5

☒ **D** 6

(Total for Question 4 = 1 mark)

5 100 cm^3 of methane, CH_4, is completely burned in 400 cm^3 of oxygen.

What is the final volume of the gas mixture, in cm^3, when all volumes are measured at room temperature and pressure?

☒ **A** 100

☒ **B** 200

☒ **C** 300

☒ **D** 400

(Total for Question 5 = 1 mark)

6 In the United Kingdom, the limit for gaseous hydrocarbons in vehicle exhaust gases is 200 ppm.

What is the maximum volume of gaseous hydrocarbons allowed in 10 mol of exhaust gases, at room temperature and pressure?

[Molar volume = 24 $dm^3\,mol^{-1}$]

☒ **A** 24 cm^3

☒ **B** 48 cm^3

☒ **C** 96 cm^3

☒ **D** 480 cm^3

(Total for Question 6 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

7 Which of these statements is the **best** evidence for the existence of ions in sodium chloride?

☒ **A** Solid sodium chloride conducts electricity.

☒ **B** When an electric current is passed through a solution of sodium chloride, the movement of the coloured ions is observed.

☒ **C** Sodium chloride crystals have a regular shape.

☒ **D** There is good agreement between theoretical and experimental lattice energies for sodium chloride.

(Total for Question 7 = 1 mark)

8 Which ion has the **smallest** ionic radius?

☒ **A** Cl^-

☒ **B** Ca^{2+}

☒ **C** K^+

☒ **D** S^{2-}

(Total for Question 8 = 1 mark)

9 Which quantity is exothermic?

☒ **A** Enthalpy change of atomisation of sulfur.

☒ **B** First ionisation energy of sulfur.

☒ **C** First electron affinity of sulfur.

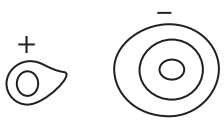
☒ **D** Second electron affinity of sulfur.

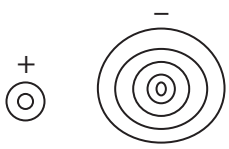
(Total for Question 9 = 1 mark)

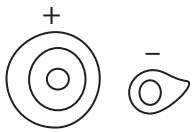
Use this space for any rough working. Anything you write in this space will gain no credit.

10 Which diagram **best** represents the electron densities in lithium iodide?

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question 10 = 1 mark)

11 Which equation represents the lattice energy of magnesium nitride, Mg_3N_2?

☒ **A** $3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

☒ **B** $3Mg(g) + 2N(g) \rightarrow Mg_3N_2(s)$

☒ **C** $3Mg^{2+}(g) + 2N^{3-}(g) \rightarrow Mg_3N_2(g)$

☒ **D** $3Mg^{2+}(g) + 2N^{3-}(g) \rightarrow Mg_3N_2(s)$

(Total for Question 11 = 1 mark)

12 In which pair are the ions isoelectronic?

☒ **A** Li^+ and O^{2-}

☒ **B** Na^+ and Cl^-

☒ **C** Mg^{2+} and S^{2-}

☒ **D** Al^{3+} and F^-

(Total for Question 12 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

13 The following statements give information about the thermodynamic stability of magnesium chlorides.

- MgCl is stable with respect to chlorine and magnesium.
- MgCl is unstable with respect to $MgCl_2$ and Mg.
- $MgCl_3$ is unstable with respect to chlorine and magnesium.

Which signs of the standard enthalpy changes of formation of MgCl and $MgCl_3$ are correct?

	$\Delta H_f^{\ominus}$ [MgCl(s)]	$\Delta H_f^{\ominus}$ [$MgCl_3$(s)]
☒ **A**	negative	negative
☒ **B**	positive	negative
☒ **C**	negative	positive
☒ **D**	positive	positive

(Total for Question 13 = 1 mark)

14 In the electrolysis of copper(II) chromate(VI) solution, the colour that develops around the positive electrode (anode) is

☒ **A** orange.

☒ **B** yellow.

☒ **C** green.

☒ **D** blue.

(Total for Question 14 = 1 mark)

15 When 10 cm^3 of a nitric acid solution reacts with 20 cm^3 of a sodium hydroxide solution, the temperature rise is ΔT.

Repeating the reaction with 15 cm^3 of the same nitric acid solution and 30 cm^3 of the same sodium hydroxide solution would give a temperature rise of

☒ **A** 0.5 ΔT

☒ **B** 0.67 ΔT

☒ **C** ΔT

☒ **D** 1.5 ΔT

(Total for Question 15 = 1 mark)

16 How many moles of **ions** are present in 30 cm^3 of 0.025 mol dm^{-3} barium hydroxide solution, $Ba(OH)_2(aq)$?

☒ **A** 0.00075

☒ **B** 0.00150

☒ **C** 0.00225

☒ **D** 0.00450

(Total for Question 16 = 1 mark)

17 When 1.270 g of copper ($A_r = 63.5$) is added to excess silver nitrate solution, 4.316 g of silver ($A_r = 107.9$) forms.

The ionic equation for the reaction is:

☒ **A** $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

☒ **B** $2Cu(s) + Ag^{2+}(aq) \rightarrow 2Cu^+(aq) + Ag(s)$

☒ **C** $Cu(s) + Ag^{2+}(aq) \rightarrow Cu^{2+}(aq) + Ag(s)$

☒ **D** $Cu(s) + Ag^+(aq) \rightarrow Cu^+(aq) + Ag(s)$

(Total for Question 17 = 1 mark)

18 The process with the highest atom economy is the production of

☒ **A** propene by cracking eicosane, $C_{20}H_{42}$.

☒ **B** 1-chloropropane from propane and chlorine.

☒ **C** cyclohexene by reforming hexane.

☒ **D** poly(propene) by polymerising propene.

(Total for Question 18 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

19 Which hazard symbol must be displayed on a bottle containing hexane?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 19 = 1 mark)

20 Which is a free radical?

☒ **A** OH

☒ **B** OH^-

☒ **C** OH_2

☒ **D** OH_3^+

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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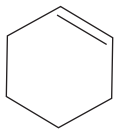
SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

21 This question is about cyclohexene which can be used to show the reactions of the alkenes.



Cyclohexene

Data: Boiling temperature = 83 °C Density = 0.81 g cm^{-3}

(a) (i) 1 cm^3 of bromine water is shaken with 2 cm^3 of cyclohexene in a test tube and the mixture allowed to stand.

Describe what you would **see** before and after shaking.

(3)

(ii) Draw the **skeletal** formula of the major organic product of this reaction.

(1)

(b) Draw the skeletal formula and give the name of the organic product formed when cyclohexene reacts with potassium manganate(VII) mixed with dilute sulfuric acid.

(2)

Skeletal formula

Name .....

(c) Suggest the skeletal formula of the polymer that would be formed if cyclohexene polymerised. Show **two** repeat units.

(2)

(Total for Question 21 = 8 marks)

22 This question is about a preparation of hydrated zinc sulfate crystals.

An excess of powdered zinc is added to 20 cm^3 of 1.00 mol dm^{-3} sulfuric acid.

(a) (i) State **two** observations you would make during this reaction.

(2)

(ii) Write the **ionic** equation for this reaction. Include state symbols.

(2)

*(b) When the reaction is complete, a solution of zinc sulfate is formed. Some unreacted zinc is left.

Describe how pure dry crystals of hydrated zinc sulfate may be obtained from this mixture.

(4)

(c) (i) The formula of the hydrated zinc sulfate crystals is $ZnSO_4.7H_2O$.

Calculate the molar mass of $ZnSO_4.7H_2O$.

(1)

(ii) Calculate the number of moles of sulfuric acid in 20.0 cm^3 of a 1.0 mol dm^{-3} solution.

(1)

(iii) 4.00 g of hydrated zinc sulfate crystals form.

Calculate the percentage yield of hydrated zinc sulfate.

Give your answer to **two** significant figures.

(2)

(Total for Question 22 = 12 marks)

23 This question is about the gases propane, C_3H_8, and butane, C_4H_{10}.

(a) (i) Propane and butane are both alkanes. Alkanes are said to belong to the same 'homologous series'.

Give **two** characteristics associated with homologous series.

(2)

(ii) Butane has a structural isomer but propane does not.

State what is meant by a structural isomer and explain why butane has a structural isomer but propane does not.

(2)

Structural isomer

Explanation

(b) Bottled propane is used as the fuel for the burners in hot air balloons. A hot air balloon carries 80 kg of liquefied propane.

(i) Write the equation for the complete combustion of propane in air under standard conditions. State symbols are not required.

(2)

(ii) Calculate the number of moles of propane in 80 kg.

(2)

(iii) The standard enthalpy change of combustion of propane, $\Delta H^{\ominus}_{c,298} = -2220$ kJ mol^{-1}.

Calculate the heat energy, in joules, given out when 80 kg of propane burns completely.

(1)

(iv) The burners have a maximum power rating of 4800 W. (1 W = 1 J s^{-1})

Calculate the maximum time, in **hours**, that the balloon's fuel would last if the burners are used continuously on full power with 80 kg of fuel.

(1)

(v) A student suggests that butane would be a better fuel for hot air balloons than propane because it has a more negative enthalpy change of combustion, $\Delta H^{\ominus}_{c,298} = -2880$ kJ mol^{-1}.

Suggest two reasons why butane is **not** a better fuel than propane for hot air balloons.

(2)

Reason one.....

.....

.....

Reason two.....

.....

.....

(c) The standard enthalpy changes of atomisation of propane and butane can be calculated. The calculation requires their standard enthalpy changes of formation and the standard enthalpy changes of atomisation of carbon and hydrogen.

(i) Complete the Hess cycle for the calculation of the standard enthalpy change of atomisation of propane.

(1)

$$3C(s, \text{graphite}) + 4H_2(g) \rightarrow C_3H_8(g)$$

..... (.....) + ... (.....)

(ii) Calculate the standard enthalpy change of atomisation of propane, $\Delta H^{\ominus}_{at,298}[C_3H_8(g)]$

Use the data below.

$\Delta H^{\ominus}_{f,298}[C_3H_8(g)] = -104.5 \text{ kJ mol}^{-1}$

$\Delta H^{\ominus}_{at,298}[\frac{1}{2}H_2(g)] = +218 \text{ kJ mol}^{-1}$

$\Delta H^{\ominus}_{at,298}[C(s, \text{graphite})] = +716.7 \text{ kJ mol}^{-1}$

(3)

(iii) The standard enthalpy change of atomisation of butane can be calculated using the same method as for propane. This value, together with the carbon-hydrogen bond energy, can be used to calculate the carbon-carbon bond energy

$\Delta H_{at,298}[C_4H_{10}(g)] = +5173.3$ kJ mol^{-1}.

E(C—H) = +412.3 kJ mol^{-1}

Calculate the carbon-carbon bond energy.

(2)

(iv) Suggest why your answer differs from the mean bond energy for the carbon-carbon bond given in data books.

(1)

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(Total for Question 23 = 19 marks)

24 This question is about the alkali metal potassium and the salt potassium chloride.

(a) (i) A sample of potassium is known to consist of isotopes with mass numbers 39 and 41.

For each isotope, complete the table below to show the numbers of protons, neutrons and electrons.

(2)

Isotope mass number	Number of protons	Number of neutrons	Number of electrons
39			
41			

(ii) Explain the meaning of the term isotope, using the information from the table in (a)(i).

(1)

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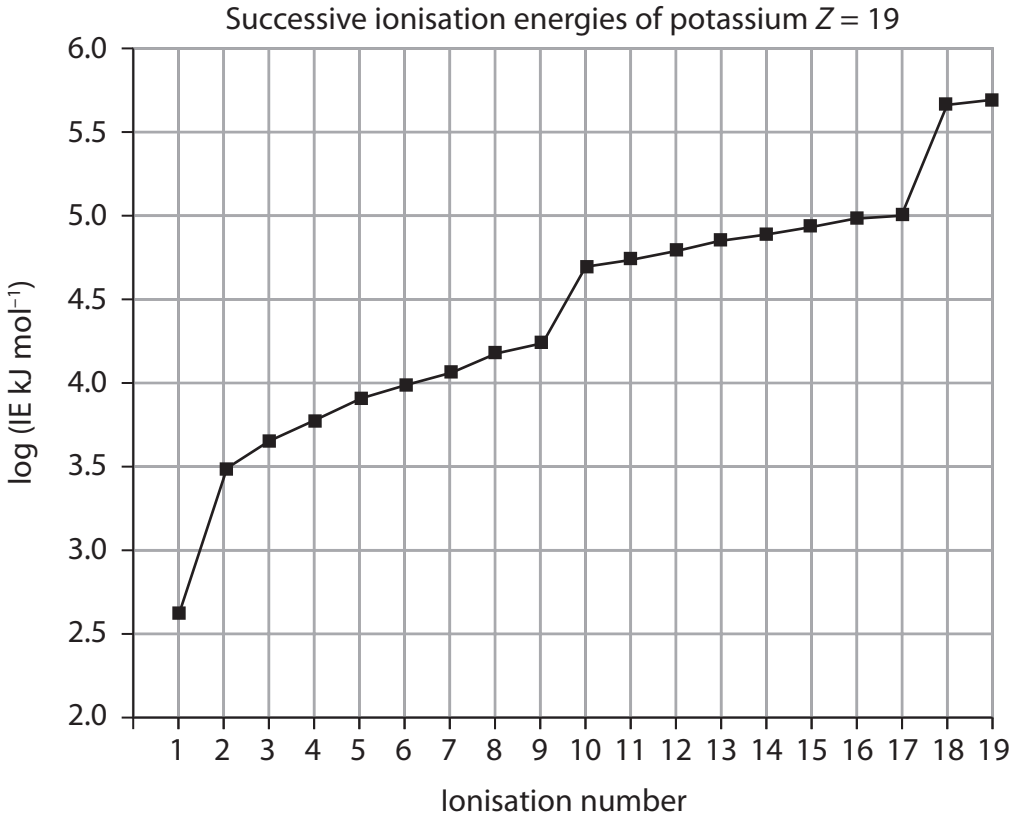
(iii) The relative atomic mass of this sample of potassium is 39.1.

Calculate the percentage abundance of each isotope.

(2)

(b) The chart below shows the successive ionisation energies of potassium.



(i) Estimate the 1st ionisation energy and the 19th ionisation energy of potassium. Use data from the graph and your calculator.

(1)

(ii) Explain why the logarithm of the ionisation energy is used in plotting this graph rather than the ionisation energy.

(1)

(iii) Write the equation for the first ionisation energy of potassium.

(2)

*(iv) Explain why there is a **general** rise in the value of the successive ionisation energies.

(2)

*(v) Explain each of the three sharp rises in the graph.

You should include details of the subshell from which the electron is removed at each sharp rise.

(3)

(c) (i) Draw a dot and cross diagram for potassium chloride.

Only show the electrons in the outer shell of both ions.

(2)

(ii) Compare the electrical conductivity of potassium metal and potassium chloride.

(2)

.....

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.....

(iii) Describe **two** similarities in the structure and bonding of potassium metal and potassium chloride.

(2)

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.....

(iv) Give **one** difference between the structures of potassium metal and potassium chloride.

(1)

.....

.....

(Total for Question 24 = 21 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

* Lanthanide series

* Actinide series